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Taxation Section

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PRIVATE COMPANIES

The Desirability of Keeping "Profit" in Line with "Distributable Income"

A very important decision of the Board of Review is dealt with on pp. 261-262 of the July, 1943, issue of the journal. In that case the company's net *profit* for income year ended June 30, 1938, was £9,694 and the whole of that profit was distributed as a dividend. The company's *taxable income* for the same year was £2,248. The difference of £7,446 between the profit and the taxable income was due to the allowance of State income tax paid during the income year, a provision for which had been made by the company in the previous year. The provision, of course, had not been allowed as a deduction in the previous year. The company unsuccessfully sought to carry the excess dividend of £7,446 forward under s. 106.

The problem as applied to s. 107 distributions may be illustrated by the following example.

Let us assume that a resident private company's profit before deduction of income taxes is £10,000 per annum for the first three years and £5,000 for the fourth year and that the appropriate rate of private company tax is 15/- in the £, constant. The company has made the election under s. 103 (3). The company does not distribute any of its distributable income within six months after the close of the income year.

(a) *Where company makes provision for all income taxes on current year's profit.*

First year.

Gross profit, less expenses		£10,000
Provision for Commonwealth income taxes:		
Ordinary income tax, £10,000 at 6/- in £ =	£3,000	
Tax under Division 7, £7,000 at 15/- in £ =	5,250	
		8,250
Net Profit		£1,750

Second year.

Gross profit, less expenses	£10,000

Provision for Commonwealth income taxes:			
Ordinary income tax, £10,000 at 6/- in £ =		£3,000	
Tax under Division 7,			
Taxable income	£10,000		
Ordinary income tax *payable*	3,000		
	£7,000		
Private company tax *paid* on first year's income	5,250		
Distributable income	£1,750		
Tax on undistributed amount of £1,750 at 15/- in £		1,312	
			4,312
Net Profit			£5,688
Third year.			
Gross profit, less expenses			£10,000
Provision for Commonwealth income taxes:			
Ordinary income tax, £10,000 at 6/- in £ =		£3,000	
Tax under Division 7,			
Taxable income	£10,000		
Ordinary income tax payable	3,000		
	£7,000		
Private company tax paid on second year's income	1,312		
Distributable income	£5,688		
Tax on undistributed amount of £5,688 at 15/- in £		4,266	
			7,266
Net Profit			£2,734
Fourth year.			
Gross profit, less expenses			£5,000
Provision for Commonwealth income taxes:			
Ordinary income tax, £5,000 at 6/- in £ =		£1,500	
Tax under Division 7,			
Taxable income	£5,000		
Ordinary income tax payable	1,500		
	£3,500		
Private company tax paid on third year's income	4,266		
Distributable income	nil	nil	
			1,500
Net Profit			£3,500

Summary:	*Net Profit*	*Undistributed Amount*
First year	£1,750	£7,000
Second year	5,688	1,750
Third year	2,734	5,688
Fourth year	3,500	nil
	£13,672	£14,438

N.B.: The difference between the two columns, £766, represents the excess of Commonwealth ordinary income tax payable and private company tax paid over the taxable income of the fourth year. The excess of £766 cannot be carried forward as a deduction in calculating the distributable income of any subsequent year.

On the most benevolent interpretation it is considered that the maximum amount available for distribution subject to the rebate provided by s. 107 is £6,234, viz.:

First year.	Net profit	£1,750
Second year.	Undistributed amount	1,750
Third year.	Net profit	2,734
Fourth year.	Undistributed amount	nil
		£6,234

Assuming that the amounts transferred to the provision for taxes account are used for the purpose of payment of taxes, the only profits available for distribution will be those which remain in the profit and loss appropriation account. Therefore, in respect of the first and third years the maximum amounts available for distribution are the net profits of those years, viz., £1,750 and £2,734.

On the other hand, a s. 107 distribution in respect of a particular year is limited to the undistributed amount of that year.

If the above reasoning be correct, the shareholders have lost the right to receive the sum of £8,204 (£14,438 — £6,234) subject to the rebate provided by s. 107 which, except in the case of primary producers, amounts to complete freedom from tax.

The original Act was passed in the Golden Age of 1936 when taxes were comparatively trifling and trading companies received a deduction of one-third of their distributable incomes in calculating what was a sufficient distribution. With the abolition of the one-third deduction and the advent of very high taxation, Division 7 urgently calls for a complete overhaul.

(b) *Where company keeps "distributable income" and "profit" in line.*

First year.		
Gross profit, less expenses		£10,000
Provision for ordinary Commonwealth income tax. (Taxpayer company made election under s. 103 (3))		3,000
Net Profit		£7,000
Second year.		
Gross profit, less expenses		£10,000
Provision for ordinary income tax	£3,000	
Private company tax paid on first year's income	5,250	
		8,250
Net Profit		£1,750

Third year.		
Gross profit, less expenses		£10,000
Provision for ordinary income tax	£3,000	
Private company tax paid on second year's income	1,312	
		4,312
Net Profit		£5,688
Fourth year.		
Gross profit, less expenses		£5,000
Provision for ordinary income tax	£1,500	
Private company tax paid on third year's income	4,266	
		5,766
Net Loss		£766

Applying the "last-in-first-out" method, the following is a summary of the above position:

		Net Profit	*Undistributed Amount*
First year		£7,000	£7,000
Second year		1,750	1,750
Third year	£5,688		
Less loss fourth year	766		
		4,922	5,688
Fourth year		nil	nil
		£13,672	£14,438

N.B.: The company could, if it so desired, and if the fund were available for the purpose, appropriate the loss sustained in the fourth year, £766, out of a reserve account consisting of some other profits, and so leave the whole of the £14,438 available for distribution subject to the rebate provided by s. 107.

The above example is so over-simplified as to be jejune. Problems associated with other provisions such as for doubtful debts, depreciation in excess of the departmental allowance, non-allowable expenditure and the like have not been discussed.

All that space permits me to say is that the ideal profit and loss account for a private company is one where the profit, as disclosed in the company's accounts, coincides with its distributable income. Where the shareholder or shareholders control the affairs of the company this task should not present any problem, but there are many other instances where it is desirable to make full provision for taxes. In this class of case, it is suggested that the difficulty may be overcome in the following manner:

(a) Create the provision for ordinary income tax and private company tax for the current year (hereinafter referred to as the first year).

(b) Transfer the amount so provided back to the credit of profit and loss appropriation account on the first day of the next year (hereinafter referred to as the second year).

(c) Debit *Commonwealth ordinary income tax* paid to appropriation account, specifically appropriating the amount—

(a) out of the first year's profit where the company has made the election under s. 103 (3);

(b) out of the second year's profits (i.e., the year in which the tax was actually paid) where the company has not made that election.

(d) Debit Commonwealth private company tax paid to appropriation account, specifically appropriating the amount out of the profits of the year in which the tax was paid.

(e) Debit State income taxes paid to appropriation account, specifically appropriating:

(a) taxes (including State private company tax) for income years ended June 30, 1938, 1939, and 1940 (or substituted accounting period) out of the profits of income year ended June 30, 1941;

(b) other State taxes out of the profits of the year in which the taxes were paid.

Example

The company commenced business during year ended June 30, 1942. It made the election under s. 103 (3).

YEAR ENDED JUNE 30, 1942

Profit and Loss Account

To Provision for taxes:		By Excess of revenue over expenditure	£10,000
C'wealth ordinary income tax, £10,000 at 6/- in £	£3,000		
Private company tax, £7,000 at, say, 10/- in £	3,500		
Balance transferred to Profit and Loss Appropriation Account	3,500		
	£10,000		£10,000

Profit and Loss Appropriation Account

1942.—June 30.		1942.—June 30.	
To Balance c/d.	£3,500	By Net Profit for year . .	£3,500
		1942.—July 1.	
		By Balance b/d.	£3,500

YEAR ENDED JUNE 30, 1943

Profit and Loss Account

To Provision for taxes:		By Excess of revenue over expenditure	£10,000
C'wealth ordinary income tax, £10,000 at 6/- in £	£3,000		
Private company tax, £3,500 at 10/- in £ .	1,750		
Balance transferred to Profit and Loss Appropriation Account	5,250		
	£10,000		£10,000

c

Profit and Loss Appropriation Account

1943.—Feb. 18.		1942.—July 1.	
To Cash, C'wealth ordinary income tax, 1942, appropriated out of profits of year ended June 30, 1942	£3,000	By Balance b/d. .. .. .. Provision for taxes account, being balance of profits of year ended June 30, 1942, transferred	£3,500 6,500
1943.—June 25.		1943.—June 30.	
To C'wealth private company tax, 1942, appropriated out of profits of year ended June 30, 1943	3,500	By Net Profit for year ..	5,250
1943.—June 30.			
To Balance c/d.	8,750		
	£15,250		£15,250
1943.—July 1.		1943.—July 1.	
To Balance c/d.	£13,500	By Balance b/d. 1942, £7,000 1943, 1,750	£8,750
			£8,750
		1943.—July 1.	
		By Provision for taxes account, being balance of profits of year ended June 30, 1943, transferred	4,750
	£13,500		£13,500
		1943.—July 1.	
		By Balance b/d.	£13,500

Again, for the sake of clarity, the example has been over-simplified and is, moreover, based on what is, in many instances, an impossible assumption, viz., that the company is able to make an accurate estimate in respect of the provision for private company tax.

The above suggestions may offend against orthodox accounting principles, but the strict application of those principles may prove an expensive luxury to the shareholders of private companies. However much I have offended in this respect, at least I have kept the good wine until the last. The following communication has been received from Mr. R. W. Chenoweth, Federal Deputy Commissioner of Taxation, Melbourne:

"Section 107 of the Income Tax Assessment Act, 1936-1943, provides:—

'A person shall be entitled to a rebate of the amount by which his income tax is increased by the inclusion in his assessable income of—

(a) dividends paid to him by a company; or

(b) amounts in respect of dividends paid by a company to any company, trustee or partnership interposed between that person and the company paying the dividends, where the dividends are

paid wholly and exclusively out of any amount or amounts in respect of which, under this Division, under section twenty-one of the previous Act or under Division 2 of Part III of that Act, the company paying the dividends has paid or is liable to pay tax.'

Some companies have experienced difficulty in determining whether the amounts which they considered were available for distribution out of profits in respect of which they had paid or were liable to pay private company tax agreed with the Departmental calculations.

As a result of representations, the Commissioner of Taxation has decided that where a company forwards to the Department calculations made from its accounts as to the amount of funds available of a type specified in the law, and requests that the calculations be checked with Departmental records, the company will be informed whether its calculations accord with Departmental records, and if not, in what respect they differ.

The matter of framing resolutions and paying dividends in such a manner as to entitle the shareholder to rebates is one for the company and its advisers. The Department is not prepared to inform a company as to the taxation consequences of any proposed action on the part of the company.

I would be pleased if you would give publicity through the columns of your journal to the above decision, which, I suggest, might be of interest to your readers."

New South Wales Death Duty

Whether bona fide possession and enjoyment of property comprised in a gift was assumed by donee to entire exclusion of donor

Section 102 of the New South Wales Stamp Duties Act provides for the inclusion in the dutiable estate of a deceased person of, *inter alia*, any property comprised in any gift made by the deceased at any time of which bona fide possession and enjoyment has not been assumed by the donee immediately upon the gift and thenceforth retained to the entire exclusion of the deceased, or of any benefit to him of whatsoever kind or in any way whatsoever.

In *Commissioner for Stamp Duties (N.S.W.) v. Perpetual Trustee Co. (Ltd.)* [1943] 1 All E.R. 525, the facts were:

In 1917 the deceased executed a settlement of 850 shares, transferring the shares to trustees, of whom the deceased was one, upon trust to apply such part of the income as the trustees should think fit to the maintenance and education of the deceased's son during his minority, to accumulate the surplus income and upon the son attaining 21 years of age to transfer the shares to the son as his absolute property. The trustees were given power to pay any moneys for the maintenance of the son to his natural or other guardian and absolved from liability in respect of moneys so paid so long as the son was properly maintained. Shortly after the date of the settlement the trustees took out a policy of insurance for £10,000 on the life of the son and paid the premiums out of income of the settlement. With the exception of the payment of such premiums, no part of the income was applied to the maintenance of the son, all other income being accumulated. The deceased died in 1921. The son attained 21 years of age in 1931, when the property was duly transferred to him.

It was contended on behalf of the Crown that the property formed part of the deceased's estate for the purposes of the assessment of death duties since the bona fide possession and enjoyment of the settled property had not been assumed by the son immediately upon the gift and thenceforth retained to the entire exclusion of the deceased.

The Privy Council has held (affirming the decision of the Australian High

Court) that the bona fide possession and enjoyment of the property comprised in the settlement was assumed by the donee immediately upon the gift and thenceforth retained to the entire exclusion of the deceased or of any benefit to him of whatsoever kind and death duties were not payable in respect of the shares, the subject of the settlement.

"For the reasons hereinafter appearing their Lordships are in agreement with the decision of the High Court in this case. In their opinion the property comprised in the gift was the equitable interest in the 850 shares, which was given by the settlor to his son. The disposition of that interest was effected by the creation of a trust, i.e., by transferring the legal ownership of the shares to trustees and declaring such trusts in favour of the son as were co-extensive with the gift which the settlor decided to give. The donee was the recipient of the gift; whether the son alone was the donee (as their Lordships think) or whether the son and the body of trustees together constituted the donee seems immaterial. The trustees alone were not the donee. They were in no sense the object of the settlor's bounty.

"Did the donee assume bona fide possession and enjoyment immediately upon the gift? The linking of possession with enjoyment as a composite object which has to be assumed by the donee indicates that the possession and enjoyment contemplated is beneficial possession and enjoyment by the object of the donor's bounty. This question, therefore, must be answered in the affirmative, because the son was (through the medium of the trustees) immediately put in such bona fide beneficial possession and enjoyment of the property comprised in the gift as the nature of the gift and the circumstances permitted.

"Did he assume it and thenceforth retain it to the entire exclusion of the donor? The answer, their Lordships think, must be in the affirmative, and for two reasons: viz., (i) the settlor had no enjoyment and possession such as is contemplated by the section; and (ii) such possession and enjoyment as he had from the fact that the legal ownership of the shares vested in him and his co-trustees as joint tenants was had by him solely on behalf of the donee. In his capacity as donor he was entirely excluded from possession and enjoyment of what he had given to his son," at pp. 530-531.

Payment to Director as Consideration for Restrictive Covenant

The decision of the English Court of Appeal in *Beak v. Robson* [1942] 1 All. E.R. 639 has been affirmed by the House of Lords [1943] 1 All. E.R. 46.

In the above case the taxpayer, on October 4, 1937, entered into an agreement with a company, in whose employment he had been for some time, whereby he was to be employed for a term of five years as director and manager at a salary therein stated. The agreement contained clauses under which, in the event of the taxpayer determining the agreement by notice, as he was entitled under one of the clauses to do, or committing a breach of it which led to its determination, he covenanted for a certain period not, without the consent of the company, to be engaged or interested in the business of a coal exporter within a radius of 50 miles of Newcastle-upon-Tyne. The taxpayer was paid £7,000 by the company on the execution of the agreement in consideration of the taxpayer entering into that covenant. The Crown contended that the £7,000 was remuneration from his office as director and manager and accordingly was taxable under the English Income Tax Act 1918. Sched. E. *Held* The sum £7,000 was not chargeable under Sched. E, because, though it was true to say that if he had not entered into

the agreement he would not have received that sum, it was not a profit from the office of director and manager. The sum was the consideration for the benefit of a covenant which only came into operation after the completion of the service.

Exemption of Musical Societies

The Royal Choral Society was formed for the advancement of choral singing in London. Its constitution provides that the income shall be applied solely towards the promotion of the society's objects. In the event of the winding up or dissolution of the society, all the property remaining after the payment of all liabilities shall be transferred to a society with similar objects. *Held* that the society was established for charitable purposes only and its moneys are applied for these purposes only, and it is, therefore, entitled to exemption from English income tax. *The Royal Choral Society v. I.R. Comrs.* [1942] 2 All. E.R. 610.

It is considered that such a society is exempt from Commonwealth income tax under the specific provisions of s. 23 (g), which exempts, *inter alia*, the income of a society not carried on for the purposes of profit or gain to the individual members thereof, and being a society established for musical purposes, or for the encouragement of music.

The decision by Macnaghten, J. in *Royal Choral Society v. I.R. Comrs.* has been affirmed by the English Court of Appeal [1943] 2 All E.R. 101.

The Court of Appeal held that whether a particular body is established for charitable purposes is a question of law and in no circumstances can it be a matter of fact.

Taxation Decisions of the Board of Review

The following is a summary of decisions recently given by the Board of Review in matters of general interest. The sections referred to are those of the Commonwealth Income Tax Assessment Act, except where there is an indication to the contrary.

Improvements—Tenant Rights. Taxpayer acquired a lease of land for a period of four years, and did not control the voting power of the lessor company. He covenanted with the lessor that on the termination of the lease he would, at his own expense, remove all buildings, fixtures and erections of any kind effected by him on the land. At the time of entering into the lease taxpayer purchased, for £150, the remaining part of an old building on the leased land, and he made additions costing approximately £1,600. When the lease expired he arranged for the demolition and removal of the buildings and received from the demolisher £240 for the materials.

The Commissioner took the view that, because of the covenant to remove the improvements and the receipt of £240 for the materials, the taxpayer had tenant rights under the lease and was not entitled to deductions of a proportionate part of the cost of the improvements.

Held (1) that the covenant was not a benefit to the taxpayer but a burden and that he had nothing in the nature of tenant rights;

(2) that only the "expenditure in *making* improvements" could be apportioned for the term of the lease, and that the sum of £150 paid by the taxpayer did not come under that description.—Section 88.

Rates and Taxes—Carrying on Business. Taxpayer bought a property for business purposes and took possession on October 1, 1940. Some months were spent in making structural alterations before the premises were opened for public trading. Meanwhile stock had been purchased, employees engaged, etc. As between taxpayer and the vendor, rates and land tax were adjusted as from the date on which possession was taken. The Commissioner allowed only that part of the amounts in question which related to the period after

public trading commenced, the disallowed portions being regarded as capital expenditure.

Held that the taxpayer was carrying on business from the date on which he took possession of the property, that the charges did not represent outgoings of capital, and that the taxpayer was entitled to the full amount of the deductions claimed.

War-time (Company) Tax

Underwriting and Preliminary Expenses. A company formed prior to 1930 incurred underwriting and other formation expenses amounting to £24,000. In subsequent years this item was reduced to £16,000 by appropriations from profits. Later, as a result of the depression, the share capital was reduced by one-third and among the amounts written off was the balance of £16,000. The position subsequently improved and the capital was increased by the issue of additional shares. Accumulated profits and reserves were applied for this purpose.

The company claimed that the benefit of the underwriting expenses still enured because those expenses represented an asset "purchased" by the company, and that, as the value of the asset no longer appeared in the accounts, the amount which should be included in the calculation of capital employed was the amount prescribed in paragraph (d) of Section 24 (2), i.e., "the cost of such asset."

In rejecting the claim, the Board said that Section 24 (2) speaks only of *existing* assets, and that the underwriting expenses, according to the company's own resolution, had ceased to exist many years before the relevant period. Consequently, it was not necessary to decide whether assets represented by expenditure of that kind could be said to have been "purchased."

Pay-roll Tax

Commission. In connection with group insurance schemes an insurance society makes payments to Government departments, banking companies, commercial undertakings and others, of a percentage of premiums collected by them and forwarded to the insurance society.

Each of the amounts so received was regarded by the Commissioner as a payment "made by way of commission to an insurance or time-payment canvasser or collector."

Held (1) that where any such payments were received by companies, etc., in respect of premiums which the companies themselves were liable to pay (under the insurance policies), the amounts could not be regarded as paid "by way of commission" but were in the nature of rebates or discounts, and for that reason alone were not subject to pay-roll tax;

(2) that the term "insurance collector" (used in the Act) marked out a well-known type of calling and was not applicable to Government departments or other public bodies (e.g., the N.S.W. Railway Commissioners) or to banking companies, hospital and university staffs, or commercial undertakings, unless the business carried on was closely associated with time-payment canvassing or collecting or with insurance canvassing or collecting.

Award Wage Increases

Procedure for Re-imbursement

The Commonwealth Treasurer has furnished the following information concerning the conditions under which refunds will be allowed by the Commonwealth Government to employers on account of the basic wage adjustments consequent upon the rise in the June quarter index.

Employers who are liable to pay-roll tax will claim their refunds of basic

wage adjustments as a set-off against the pay-roll tax in respect of the last month of the quarter beginning with the month of August, 1943. During October next, those employers will receive from the Taxation Department forms of application for refund of the basic wage adjustments paid by them during the quarter—August, September, October, 1943—together with necessary instructions. The completed applications for refunds should be attached by the employers to the pay-roll tax returns to be lodged by them in November in respect of October wages. The amount of the refund claimed should be set off against the tax payable as shown in the return to which the refund claim is attached. If the return should exceed that tax the balance may be carried forward and set off against the tax of later months.

In calculating the pay-roll tax payable by an employer the full amount of wages paid by him, including the basic wage adjustments, must be taken into account. Employers will, however, not be entitled under the scheme of refund of the basic wage adjustments to any refunds of the additional pay-roll tax payable on the amounts of those adjustments.

Employers who are not liable for pay-roll tax and who desire to apply for refunds of basic wage adjustments will be able to obtain application forms either by personal application to the nearest National Service Officer or by written application to any National Service Office. After completion of the claim form it should be lodged at the Commonwealth Sub-Treasury in the capital city of the State concerned. These applications must also be on a quarterly basis. The necessary forms are available.

Refunds will be made only of the basic wage adjustments under awards, agreements, etc. (Federal and State) in respect of variations consequent on the rise of the June quarter index (Court Series of "C" Series Index Number).

The Government has decided to allow overtime payments to be taken into account in the claims for refunds, but workers' compensation payments cannot be included.

Employers will be required to certify that the amounts of refund claimed have been excluded by them from all costs of manufactured goods and have not been passed on either directly or indirectly in any charge for goods or services. Manufacturers who are making goods for the Government under cost plus or any other form of contract must act accordingly and should claim their refunds in the same manner as other employers.

Dealing in Foreign Exchange

The appellant company is a tobacco manufacturer. It was in the habit of buying large quantities of tobacco leaf for cash in the United States. As a result of the British Treasury's request on September 9, 1939, that the company should stop all further purchases of tobacco leaf, it had in hand a large surplus of dollars which it had bought to pay for these purchases. On September 30, 1939, the appellant company was required, under the Defence (Finance) Regulations, to sell the surplus dollars to the British Treasury. The company contended that the profit arising from this sale should not be included in the computation of the profits of its trade, on the ground that the purchase of the dollars was in effect a temporary investment in foreign currency.

Held, that the profit made by the company on the compulsory sale of its surplus dollars to the Treasury was assessable income, being part of the profits of its trade. *Imperial Tobacco Co. (of Great Britain and Ireland) Ltd. v. Kelly; same v. I.R. Comrs.* [1943] 1 All E.R. 431.

The Case for the Spending Tax

By J. K. M. CARROLL, B.COM., A.I.C.A., A.C.A.A., A.A.I.S.

War finance inevitably becomes a battle against inflation as distinct from mere price increases. So long as there are unused reserves of labour, capital and raw materials, true inflation will not occur, although there may be a general price rise. Such a rise normally stimulates production and consumption and reduces the unemployed reserves.

In war there are no unemployed reserves of labour—wages are good, overtime is frequent, spending power is high. Capital, too, is fully employed and incomes of entrepreneurs tend to rise. At the same time as consumers' incomes are increasing, the available supply of consumption-goods is diminishing, for a large part of the products of industry are being diverted to war purposes. In such circumstances, prices, unless prevented, would rise steeply, but without calling forth any additional supply—essential goods would be unevenly distributed and much individual hardship would result.

It is to prevent such consequences that drastic controls have been instituted. Rationing, price control, increased direct and indirect taxes, and the raising of large Government loans are controls familiar in most countries. There has lately been under discussion, particularly in the U.S.A., another method known as the "Spending Tax," and which is designed to syphon-off excess spending power, either as a straight out tax or as a compulsory loan, or as a mixture of both.

In brief, the proposal is to levy a direct tax on "luxury spending," that is, all expenditure on consumption-goods above a reasonable minimum. Providing a person's total spending on consumption-goods did not exceed the basic "reasonable" amount no tax would be payable, but once that amount was exceeded the rate of tax would be steeply graduated so as to provide a salutary check to excessive spending.

The following examples will make the proposals clearer and demonstrate the steeply progressive rate of tax to be applied:

Example 1

Single person without dependants:

Income from all sources		£300
Deduct: Taxes Paid	£20	
Purchase of War Savings Certificates	20	
Medical Expenses	10	
"Subsistence" Allowance	200	
	—	250
Balance = Luxury Spending		50
Rate of Tax 10%		= £5

Example 2

Married person with one dependant:

Bank Balance at July 1, 1943	£100	
Income from all sources	500	
	—	£600
Deduct: Taxes Paid	70	
Medical Expenses	10	
Investment in War Loans	100	

Subsistence Allowance	400	
Bank Balance as at June 30, 1944	20	
		600
Balance = Luxury Spending		nil
Tax		nil

Example 3

Married person with one dependant:

Bank Balance as at July 1, 1943	£400	
Income from all sources	1,500	
		£1,900
Deduct: Taxes Paid	400	
Medical Expenses	20	
Life Assurance Premiums Paid	100	
Investment in War Bonds	100	
"Subsistence" Allowance	400	
Bank Balance as at July 30, 1944	280	
		1,300
Balance = Luxury Spending		£600
Rate of Tax 40%	=	£240

Example 4

Married man with three dependants—wife and two children:

Bank Balance as at July 1, 1943	£200	
Income from all sources	2,500	
		£2,700
Deduct: Taxes Paid	800	
Medical Expenses	50	
Educational Expenses	100	
"Subsistence" Allowance	600	
Bank Balance as at June 30, 1944	350	
		1,900
Balance = Luxury Spending		£800
Rate of Tax 50%	=	£400

An examination of the foregoing examples will show:

1. Full allowance is made for all essential expenditure such as medical expenses, school fees for dependants, life assurance premiums and similar expenses.
2. Investments in War Loans is regarded as a deductible expense and so an added inducement is given to such investments.
3. Reasonable allowance is made for "subsistence." This amount would be substantially greater than the "Dependants Allowance" at present granted by the Income Tax Act.
4. As well as giving information of total income received it would also be necessary for the taxpayer to furnish particulars of bank balances at the beginning and end of the year. Also, though not shown in any of the examples, particulars of any other capital transactions would have to be included.

5. After adequate allowance has been made for all essential expenditure and investment the balance of "Luxury Spending" would be subject to heavy penalty taxes at rates which would rise steeply as the *amount* of "Luxury Spending" increased.

In effect the proposed tax amounts to a graduated sales tax, and, as such, has much to commend it. The sales tax at present in operation falls with equal severity on rich and poor alike, and, worse still, taxes commodities which, while luxuries to most, are essential to some. The spending tax would not suffer from this disadvantage, because the "Subsistence Allowance" would be adequate for all reasonable needs and the balance could truly be called luxury spending.

In the U.S.A., where the proposals were first put forth, the fear of inflation is very real. Prices have risen for most staple foodstuffs and supplies are becoming scarce. Further, the spending power in the hands of the public is rising more steadily than the Government has been able or willing to withdraw it, either by means of taxes or compulsory loans. In such circumstances, then, it is not surprising that considerable attention has been given to the spending tax proposals.

In Australia, drastic government control has existed from the outbreak of war, first in the form of price control and later supplemented by rationing and a substantial loan programme. At the moment the greatest loan campaign in our history has just been launched and special efforts are being made to attract small investors. Just how successful this will be in reducing the ever-growing volume of spending power remains to be seen, but, even if the loan is filled by small subscribers to the limit of their present ability, another loan of similar magnitude must be floated in the near future to take care of the spending power that will accumulate over the next few months.

Many suggestions for compulsory loans have been made ever since the beginning of the war, but these have been opposed because it has been claimed that the suggested methods would severely penalise many people. If, however, the compulsory loans were to be made along the lines of the spending tax proposals that objection should disappear.

War-time Cost Accounting in the Air Force

By FLIGHT-LIEUTENANT H. F. FOX, R.A.F.V.R., F.R.A.N.Z., A.C.A.A., A.A.I.S.

"The war must be won regardless of cost." The truth of that statement is admitted, but it is regrettable that many have repeated it with sheep-like simplicity. They have not considered its full implications; it sounds well, and it is so easy to repeat trite savings without stopping to think for oneself.

What does it mean? It means that the war must be won regardless of the cost to you and me; that it must be won even if you and I are reduced to the level of half a slice of dry bread per day; to the level of rags on our backs; that it must be won even at the expense of our not seeing another picture show or smoking another cigarette until victory has been gained. We would regard these as serious deprivations—some cavil even at present conditions—but it *is* true that the war must be won regardless of cost, even at the cost of our being deprived of these things, but that is not an open sesame to extravagance or inefficiency by our fighting forces.

War time brings no merit or benefit in wastefulness or inefficiency. Even boom periods of peace cannot condone these things; in war time, when both

manpower and materials are in short supply, wastefulness and inefficiency are little different from sabotage.

Warfare, like most other activities, affords opportunities for inefficiency, and where any but the most efficient measures are employed the additional cost will fall upon the taxpayer either immediately in the form of increased taxation or later as taxation which is appropriated for the amortisation of war loans. Moreover—and this is even more important—the wastage of manpower or materials may result in a weakening of striking power; for example, the grounding of aircraft through lack of manpower or spare parts required for their maintenance. It must always be borne in mind that every weakening of our power produces a corresponding advantage to the enemy.

Special Difficulties of the Services in War Time

Most war organisations are afflicted with a difficulty which exists only to a much smaller degree in peace-time enterprises; this difficulty is inadequately qualified personnel. This is the natural repercussion of a number of factors, most of which are closely allied. Among these are:

(a) The need for rapid transference of large numbers of men and women from peace-time occupations and domestic duties into the fighting and ancillary services has prevented them from receiving the full degree of training which pre-war concepts would have regarded as necessary.

(b) Rapid mobilisation has made it almost impossible to ensure that every person is employed to the best of his ability. There are more "square pegs in round holes" than one normally meets in times of peace.

(c) Most of our leading thinkers and organisers could not have joined the services immediately after the outbreak of war without upsetting the commerce of the country. Time was needed before they could hand over the reins of the enterprises which employed them. But promotion in the services still depends very much upon length of service, and consequently their abilities are not being used to full capacity.

These factors have been recorded in order to assist in an intelligent appreciation of the basic difficulties with which the services are faced. It is impracticable to decide on a means of alleviating any difficulty unless its existence is recognised. The basic difficulties appear to exist in all the services (and not only in those of Australia), but from this point reference will be made more specifically to the Air Force, because that is the arm with which the writer has elected to serve and of which he consequently has the greatest knowledge.

Functions of the Air Force

What does the Air Force do?

(a) It trains pilots, gunners, navigators, riggers, mechanics, wireless operators, storekeepers, clerks, cooks, sick-quarter attendants, and people who will be employed on a host of other duties.

(b) It provides a maintenance and repair service for its aircraft, motor vehicles, and other equipment. This involves ancillary services such as supply and transport.

(c) It operates weapons of offence and defence. This combines such associated functions as reconnaissance.

(d) It provides supplies and services necessary for maintaining its personnel in good health. These include provision and preparation of food, provision of accommodation, provision of clothing and other requisites, and provision of medical and dental facilities.

It will be seen that the Air Force is a highly complex organisation which involves numerous repetitive functions, and many of these are not affected by activities of either the enemy or our own operational aircrews. For example, operational activities in the majority of cases should not have any effect on the training of pilots, the routine maintenance of aircraft, nor the hospitalisation of sick personnel.

Aids to Management and Cost Control

By what means can aids to management be provided for officers controlling the functions which have just been enumerated? How can the efficiency of the various sections be measured, and what steps can be taken to watch cost trends in order to ensure that war funds are not wasted? If these questions were addressed to experienced business men in relation to commercial enterprise or a munitions factory, their answer would be "Cost accounting." The same answer applies when the questions refer to the Air Force, except that the actual fighting—the operation of weapons of offence and defence—are not entirely suitable operations for cost accounting; they are *destructive* activities, the others are *constructive*.

But manpower is in short supply and war expenses are already high; the question naturally arises, "Can manpower be spared for cost accounting?" The answer can be in the affirmative only if the cost accounting justifies itself by pointing the way to channels of greater efficiency or economies which will more than offset its expense in both money or manpower, or by developing a cost consciousness which will tend to prevent inefficiencies and uneconomic practices. The abundance of peace cannot justify cost accounting unless it measures up to this standard; the shortages of war make this requirement even more necessary. In what manner can cost accounting be an aid to management in the Air Force?

All Air Force units can be analysed according to their activities, and certain of these activities are common to all or many units irrespective of the major functions of the units. Most units cook meals for their staff and trainees, and although there are some exceptions, there should normally be no variation in the cost of food preparation at flying training schools, stores depots, and other types of unit. This cost can be measured easily on a "per meal" basis, and departures from standard costs can be subjected to examination and corrective action. Then, too, all personnel have to be paid; why not examine pay accounting costs on the basis of providing pay services for a hundred individuals? Once again, corrective action is called for if investigation of high accounting costs reveals inefficiencies.

The handling of equipment, the processing of photographs, the operation of motor transport, the operation of communication services, and numerous other activities (both technical and non-technical) offer excellent opportunities for the functional examination which cost accounting can provide. These can all be handled on the standard cost system; instances of inefficiency can be disclosed and their extent measured; appropriate action can be taken to overcome these inefficiencies, and the action in most cases would take the form of reduction in expenditure of either manpower or materials—those two essentials of which Australia is in such urgent need.

Variations in types of aircraft or changes of policy will generally affect only a restricted number of functions—the others will continue as before. Any attempt to approach the problem by viewing an Air Force unit merely as a complete entity would result in failure; but that could be nothing more than cost finding—certainly not cost accountancy in its true sense. A commanding officer needs all the help that cost accounting can give him. If he

is told that inefficiency is occurring in his unit he requires the information to be localised and interpreted for him in a manner which he can understand. He may be in a daze if told that his workshops overhead costs are excessive, but he will understand if told that the proportion of staff employed on supervisory work is 20 per cent. above the standard. He will not know what to do if told that the cost of preparing meals is a penny a meal above the normal, but he can take prompt action if told that twice the normal amount of fuel is being consumed.

It is an important fact that the volume of work which would be involved in this cost accounting would not be unduly great. Much of the information is being extracted at the present time; what is chiefly required is a certain correlation of this information. It would then be no longer a mass of figures to be lost on files or between book covers—it would lend itself to interpretation and could be of vital use as an aid to management.

Ancillary Uses of Cost Accounting in the Air Force

An ancillary use for cost accounting in commercial enterprise is that of cost finding, in fact it is well known that at one time this feature was regarded as its major function. A similar benefit can be derived by the Air Force.

Estimates based on the cost figures can be used as the basis of a system of budgetary control.

When a number of allied forces operate together it frequently becomes desirable for one to obtain certain supplies or services from the other. For example, one service may overhaul aircraft for another. An aeroplane is a highly intricate piece of mechanism with thousands of different parts, and during an overhaul every one of these must be examined and replaced if found to be worn or faulty. A motorist may feel annoyed if the garage's account for overhauling his car extends into two pages of detail, but a detailed account for overhauling an aircraft would be far longer than this. There are two alternatives. Detailed workshop records can be maintained to permit the preparation of itemised accounts, but this would prove expensive and would impose a heavy drain on manpower. On the other hand, by the application of costing in less detail an average cost figure can be obtained for each type of overhaul. The clerical work of recording and invoicing each job in detail can then be dispensed with and the invoice reduced to a single line.

Summary

It may be desirable to summarise this review in concise form—

(a) Avoidable inefficiency cannot be condoned—it is wasteful of both manpower and materials.

(b) The Services are faced with inherent difficulties which tend to result in inefficiency.

(c) Commercial enterprise, which is not faced with these difficulties to the same extent (and even less in peace time), finds that a sound cost accounting system pays. It should pay the Air Force even better dividends.

(d) Variations in types of aircraft, changes of policy, and even enemy action, will not upset a cost accounting system to the extent which might be expected from only casual thought.

(e) Sound cost accounting in the Air Force could point the way towards effecting real economies of manpower and materials, with resultant benefit to the war effort. It could be an aid to victory!

War-time Responsibilities of Business Executives

By C. L. S. HEWITT, B.COM., A.I.C.A., A.C.A.A.

National Security (Timber Control) Regulations

An amendment to these regulations extends the powers of the Controller of Timber to the products known by the trade names of "Masonite" and "Caneite," and similar products.

War Service Estates Regulations

These regulations, which are deemed to have effect as from 13th October, 1943, are made under the War Service Estates Act, 1942-1943. They provide for the distribution of the war service estates of deceased members of the naval, military and air forces.

Women's Employment Regulations

These regulations, made under the Women's Employment Act, 1942, have been amended. Amendments provide for applications to be made by employers proposing to employ female labour, to the Women's Employment Board, for a decision as to whether the females may be employed in work which is ordinarily performed by males, and the terms and conditions upon which they may be employed. Provision is also made for the recovery of payments that are due to female employees.

National Security (Holidays and Annual Leave) Regulations

These regulations replace similar regulations gazetted earlier. Provision is made for the Minister for Labour and National Service to direct employees or employers to work on holidays. In addition the Minister is also empowered to publish in the *Gazette* a notice declaring any employer or employee to be a person to whom annual leave or recreation leave shall not be granted except at a time determined by the Minister.

National Security (General) Regulations

An order published under these regulations provides for the regulation of the manufacture and distribution of asbestos cement sheets to ensure that supplies of these are available for defence purposes. The Minister for War Organisation of Industry or the person authorised to act on his behalf is empowered to give directions relating to the manufacture, distribution or use of any such asbestos sheets, and may require persons to obtain his consent before making use of them.

National Security (General) Regulations

An order published under these regulations provides for the control of the manufacture of domestic furniture. In addition to the registration of furniture manufacturers, the order prohibits the manufacture of certain articles of furniture. The second schedule to the order lists a number of articles of domestic furniture which may be manufactured but only in accordance with specifications which have been approved. Manufacturers may be required to submit specifications of any type of domestic furniture which it is proposed to manufacture.

National Security (Landlord and Tenant) Regulations

An amendment to these regulations provides for ejectment proceedings to be undertaken by a landlord against a tenant, when the premises are reasonably required for personal occupation by some person who ordinarily resides with and is wholly or partly dependant upon the landlord. Previously the regulations required that the landlord should need the premises for his personal occupation.

The Auxiliary Number and Its True Make-Up

By Edgar Vivian Arentz, a.c.a.a., etc.

The auxiliary number to be investigated in this article has been given (by earlier students) the stupefying title, that of "logarithm." In fact one of the first researchers into this branch of arithmetic, John Napier, who lived in years 1550-1617, called his initial table "Mirifici logarithmorum, ... , etc.," the whole wording thereof being (speaking metaphorically) half a mile long. This work was published in 1614.

The movement in the auxiliary is very powerful and this may be gauged from the following: If we were to invest just one single penny at compound interest at 3½% p.a., at the end of 1,500 years this penny, plus accumulations, would reach (say in £'s stg.) an amount $= £\frac{(1{\cdot}035)^{1500}}{240}$

To evalute by logarithmic tables, we have:

1500 times log 1·035 — log 240 = 20· 03031 34476 93231 34248

antilog = £107,229,294,271,479,380,311, very near.

We would have been chary about illustrating the tremendous sum to which one penny reaches in 2,000 years say at 5% p.a.

Now suppose we were to capitalise the vast sum shown, and then visualise the annual income therefrom, assuming its earning capacity at 4% p.a. (for every man, woman and child in the world, take a guess of 1,500 millions of them) but stating such income as the daily amount available to each. Then the daily income would $= \frac{107,229,294,271,479,380,311}{25 \times 365{\cdot}25 \times 1,500,000,000} =$ £7,828,742, nearest £.

Thus, in such manner, £7,828,742 represents the daily income for every person on earth from the investment of the principal sum at 4% p.a. Come, let us test our arithmetical ability in such connection.

	1500 times log 1·035	=	22·4105247, in brief.
Less:	log 240 =	2·3802112	
	„ 25 =	1·3979400	
	„ 365·25 =	2·5625902	
	„ 1500. M. =	9·1760913	
		=	15·5168327
∴	log of daily income	=	6·8936920
∴	antilog	=	7,828,742.

In fact, as we see, the thing is just like falling of a bally "log," and which goes to prove the diligence of our old night school master.

In the above illustration we have taken things relatively small and things relatively large—one penny to many billions upon billions of pounds sterling. What a world for goats to live in! Munch, munch, munch. £7,828,742 per person, per diem! "Yes, Teller, bai jove keep the odd £828,742; really top hole, what!" Why, it certainly puts those public financiers who saved Australia in the 1930-36 depression into the category of green-horn. Obviously it is not only in the matter of money values that we have the conception of relativeness. For instance, a man who may have saved only one person from the very jaws of a nasty old shark could only

be classified as one of minor importance in standard with that individual (or say a small congregation of individuals) who may have saved a huge number of persons from the throes of a great depression.

This is good logic, since such a horrible large school of sharks would have had to be quelled in this circumstance. Notwithstanding, we have to concede that in time such a munificent effort will slide into nothingness if notice be taken of the reasonings of our more distinguished scientists regarding the present age and the total life span (suitable for human habitation) of this our earth and the length of time man has already crawled and walked its surface. For, if a graph were to be produced upon which we sought to project the length of time the earth has been in existence, and the length of time man has inhabited its surface, man's existence in comparison would hardly be seen against that of 3,000,000,000 years equalling the present age of the earth, since man, the animal, has only blessed this planet for, say, 500,000 years. But, further, if our scientists prophesy correctly, man will continue to dwell upon this earth for many millions of years to come. And that is dealing with things relatively small and relatively great in an immeasurable universe in which the earth becomes a mere speck and man (not yet half civilised) assumes something less than the dimension of a microbe. Still, millions of years——who knows? Then, say in a space of time more minute than a flick from now—10,000 years, men who were of real genius like, for example, Napier, Edison, Newton, Pasteur, and many others of greatness in their day, may be utterly unknown, or quite forgotten. It would be extremely doubtful whether, in 10,000 years from now, those geniuses of such glittering brilliancy who were the means of saving Australia in the 1930-36 depression will be vaguely remembered by the people living in that advanced age.

But is there anything worse than toothache? Yet, for that matter, the terrible pain occasioned thereby may only be relative. Actually we had a touch of this malady the other evening, and, to relieve things, tried a walk—smoking a cigar as we bowled along. On the return journey an old shipmate was bumped into, and after walking only a few steps he remarked upon our unnatural quietness. "Toothache," we replied. Then came the rejoinder, "Toothache! Do you know I've just come direct from Bert Bumstern's, where the two of us consumed a full bottle of Genu-hine Australian whisky while listening in to the latest policy speech." That was the old stoker's way of illustrating the theory of relativeness. Thank you, ladies and gentlemen.

Now for the real job. In dwelling for a moment upon the text-book writer on the procedure of the auxiliary number, we find invariably that he is honest enough in delineation, but uncannily lacking in the matter of marshalling that simplicity surrounding the groundwork so very much desired by the average uninitiated. But we may say that a failure to read and digest authoritative gleanings on the logarithmic function has been the cause of some rash (and grotesquely so) statements appearing in various volumes on mathematics at a point where the writers concerned have had to consider something of the movement. We have encountered quite a few gifted authors falling headlong into traps set for the unwary. For instance, such writers tend to commence their respective chapters by making a preliminary remark or two on the "Napierian" system. They inform us to the effect that Napier was the man who invented logarithms, and "that he used the base $e = (2{\cdot}7182818 \ldots .)$." Plainly, to us at any rate, this sort of instruction is rubbish, since Napier knew nothing at all regarding the limiting value (e), or of its great potentiality in the construction of logarithms. No, friends, it was the irony of fate which allowed Napier to spend some twenty years on

his first table (in futility) because neither he nor his contemporaries were in a position to speak of the limit as:

$$e = \underset{n \to \infty}{\mathrm{LT}} \left(1 + \frac{1}{n}\right)^n = 1 + \frac{1}{1} + \frac{1}{1 \times 2} + \frac{1}{1 \times 2 \times 3} +, \text{ etc.,}$$

n proceeding to infinity, or to greatness. Moreover, Napier did not use the idea of a base at all for his logarithms which had to do with logarithmic sines and not with numbers in general. Here is the truth in specific sense: The system of logarithms to base (e) was merely designated "Napierian" to honour that great genius, and for no other reason.

By the way, if any of us should be at all inclined to feel overpleased with respect to our prowess in arithmetic, it will only be necessary to pursue a reading of Napier's methods in the production of his table. As for myself (personally) when recourse has been taken in such connection,—well! Have any of my readers a true conception of what it would feel like to be suddenly turned into a pair of old boots, coated in liberal fashion with blacking and no earthly hope of being polished? Just that unhealthy feeling of sogginess. That's just exactly it!

However, we do not contemplate but little space in illustrating our point in such link-up, nor do we expect readers to assimilate the fundamentals or reasonings wrapped in small parcels. But this, and other discussion further on in the article, has only been enlisted as complementary, and in no wise is it put forward to intrigue or confound those whose knowledge of elementary algebra is not competent. Nevertheless, the demonstration will be of benefit to the student even though not understood at the moment, and there has been an eye to such end.

Speaking of mathematical "ability," we would surely need very many life spans to provide any sort of chance for covering all branches of the science.

Newton, we are told, treated the plaudits of the crowd with that measure of good humour that it deserved. He was a shy little man. So, too, was Euler, and Legendre was extra timid in the display of his genius with regard to mathematics. And there you are, all of such calibre having with them the realisation of the natural obstruction, and its stultifying influence, which is the bugbear of the honest researcher in knowledge of a full comprehensiveness. Thus, the more learned a man may be, the more quiet does he become. Hard study maketh man a poor talker, and, so, that attribute which goes to make for the successful politician is lost to the student of science for ever.

Now Napier's table showed logarithmic sines of all angles for every minute of the quadrant. The real genius and beauty of his work here sprang from the crudeness of the theory advanced in outlining the various geometrical progressions and corresponding arithmetical pointers to requisite values sought. Napier, for the purpose of his table, was compelled to extract numbers which would allow him to set forth the logarithmic sines to the extent of 5,400, or 90×60, when considering 60 minutes to every degree and 90 degrees to every right angle in the quadrant. This marvellous feat was accomplished just as though the number ·9999999 had been taken in 81,425,310 factors. This, step by step, in geometrical progression would (if $y = 81{,}425{,}310$) assume:

$$1,\ \cdot 9999999,\ (\cdot 9999999)^2,\ (\cdot 9999999)^3,\ \ldots\ldots,\ (\cdot 9999999)^y$$

But Napier, by virtue of sines being taken as whole numbers and not decimal quantities as they are in our day, multiplied each term by 10^7 or 10,000,000 as he went along.

Napier, however, did not attempt to complete this physically impossible task (81,425,310 terms!); he was too astute. One hundred terms was sufficient with the aid of two or three other short tables which were dovetailed thereto in most marvellous manner. To-day we would be quite safe in taking every brilliant mathematician in the world and betting each and every one a thousand pounds to a farthing that he would not be able to solve Napier's problem if things stood as in that student's day. And what regarding the great capabilities of Henry Briggs, Napier's co-adjutor? But seeing that we may not have twenty or thirty times the space allowed for this article, for the present enough said. Nevertheless, any readers who would care to study Napier and Briggs in brief may have recourse to the "Napier Memorial Volume," by G. C. Knott, which is available from any university library. Our copy came direct from the Royal Society, Edinburgh. In order to join our theme on the logarithmic function we may first ask this pertinent question: Why was a table of logarithms required?

Answering this question from the point of view of existing circumstances in the 16th and 17th centuries we have no hesitation in stating that such an auxiliary was very much requisite in order to relieve the load upon computers in astronomy and navigation who found it necessary to produce (and what we might term frightful) multiplication and division sums time and time again as and when similar problems had to be solved in daily routine. Napier's work was meant to be specific to such requirement; and, as indicated previously, it was trigonometrical. The table was a failure and Napier was aware of its futility long before he had finished it. But this student had courage as well as ability and so he published the work to show the scientific world just what had been accomplished. The rich reward for this action was that Napier was thereupon acclaimed one of the greatest of geniuses. That he deserved this distinction there is no room for doubt.

Next we have Napier and Briggs in collaboration on the production of a "better kind of table." In this they sought to incorporate numbers generally and not mere sine values. Briggs was the master mind in this connection. Napier, however, anticipated him with largely improved theory. The reward here was for Briggs, since, at this period, Napier's health was failing so fast that the first-named undertook all the work involved. Briggs published his table in 1624. Our present table of logarithms is based upon the work of this student. The base is 10, but Briggs did not observe this feature, since his approach to the subject had to be geometric and not algebraic. To get the definition of a logarithm (in modern sense) we have:

"The logarithm of a specified number to a given base is the index of the power to which the base must be raised in order to equal the number which is given."

We may have any base whatsoever, not 0, or zero. Take base 2, and we have:

$$2^4 = 16$$
$$\therefore \log_2 16 = 4.$$

(Note: $\log_2 16$ is read as "the logarithm of 16 to base$_2$." [It equals 4].)

What a terrifying operation! But, however, not to the boy or girl with some power of deduction. Here, in the above, we merely say if 2 be raised to the fourth power like, $2 \times 2 \times 2 \times 2$, the value 16 will be resultant therefrom. Therefore, 4 is the index of the power to which 2 (or the base) must be raised in order to produce 16, or the specified number.

It is abundantly clear from this procedure that 4 is the logarithm of 16 to

the base 2 in accordance with definition. Expressed in general terms, we may have:

$$\text{let, } a^x = y;$$
$$\text{then, } \log_a y = x.$$

This was the algebraist's definition—neither Napier nor Briggs had any true conception of a base for their respective systems—and consequently much nonsense has been written regarding the supposed base used by Napier in his first table. Briggs' table did have a base (base 10), but owing to his scant knowledge he was unable to recognise it.

Briggs to a friend: "I am still at my logarithms, but can neither finish them to my mind nor leave them alone . . . ."

Let us compile a miniature table of logarithms using 2 (for simplicity) as its base. Here we must have two series, one in arithmetical and the other in geometrical progression. The first will progress by a common difference of 1, while in the other our progress is governed by a common ratio of 2. This is:

Positive Side—	
Log's in A.P.	0, 1, 2, 3, 4, 5, 6, ...
No's in G.P. or	1, 2, 4, 8, 16, 32, 64, ...
	$2^0, 2^1, 2^2, 2^3, 2^4, 2^5, 2^6, \ldots\ldots$
Negative Side—	
Log's in A.P.	0, −1, −2, −3, −4, −5, −6, ...
No's in G.P. or	1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{64}$, ...
	$2^0, 2^{-1}, 2^{-2}, 2^{-3}, 2^{-4}, 2^{-5}, 2^{-6}, \ldots\ldots$

Before we proceed from this phase, in case any reader does not know what is the purport of an algebraical sum, a little light will be thrown thereon as follows:

In arithmetic proper we cannot subtract a value such as 12 from 2. In fact there would be no real meaning from the result. However, in the language of elementary algebra, if a storekeeper buys 7 dusters and sells 2 dusters, he has 5 additional to those on hand at the commencement. Again, if he buys 2 dusters and sells 7 dusters he has 5 less than those on hand at the commencement. Then by elementary algebra,

$$7 \text{ dusters} - 2 \text{ dusters} = +5 \text{ dusters.}$$
$$\text{Also, } 2 \text{ dusters} - 7 \text{ dusters} = -5 \text{ dusters.}$$

Actually the movements hinge on what we call the taking of the algebraical sum after changing the signs of the values to be subtracted. Let us consider briefly—we have no intention of embarking upon "tiny tot" algebra—as follows:

$$\ldots\ldots, -6, -5, -4\ -3, -2, -1, 0, 1, 2, 3, 4, 5, 6, \ldots\ldots$$

Now algebraical quantities with + prefixed are said to be positive. Where there is no sign a positive value is assumed. When values are prefixed by − (the minus sign) such values are known to be negative. Watching the scale above, if a boy runs 4 yards on the positive and then comes back 2 yards, his position will be $4 - 2 = +2$ from the zero commencing point. On the other hand, if he runs 4 yards and then comes back 6 yards, his position on the running track would be $4 - 6 = -2$; this is on the other side of zero, or commencing point. Thus we observe that +2 and −2 are of equal distances, only that they are in opposite directions.

$$\text{Then the sum of } +2 - 2 = 0.$$

To add like terms in positive sense is the same in algebra as in arithmetic. This is:

$$+ 8 + 9 + 10 = 9 + 8 + 10 = 27.$$

We get no logic in minus quantities in arithmetic, but in algebra we could by adding $-5\ -4\ -10\ -8$ arrive at -27.

By combining both sides to get the algebraical sum, we produce:

(+)	(−)
8	5
9	4
10	10
	8
+27	−27 = 0.

By using similar doctrine, add $+15$ to -29 and we get -14. This is again merely taking the difference in the two values and prefixing the sign appropriate to the larger in the result arrived at.

The doctrine in subtraction is equally well balanced. Say we have

$$4 - (2 + 1) = 4 - 2 - 1 = 1.$$

Since from 4 the total $(2 + 1) = 3$ is to be taken, it is of no account whether we subtract in one lump sum or in piece-meal fashion.

Again:

$$4 - (2 - 1) = 4 - 2 + 1 = 3.$$

Also:

$$4 - (8 + 2) = 4 - 8 - 2 = -6.$$

This of course brings us to the fundamental rule—When an expression enclosed within brackets is preceded by the minus sign, the brackets may be removed by changing all signs within the brackets.

Contrawise, when an expression is placed within brackets with the minus sign prefixed all signs within the brackets must be changed.

That is what our work above suggests and so to subtract according to rule change the sign in the value to be subtracted and add by the procedure in algebra demonstrated at first. Let us look at the following in this connection:

(a) Subtract 6 from 4, and the answer is $+4 - 6 = -2$, or, $4 - 6 = -2$. We could have stated at first

$$4 - (6) = 4 - 6 = -2, \text{ as above.}$$

(b) Subtract -4 from 6, and the answer is $+4 + 6 = +10 = 10$. Or, $6 - (-4) = 6 + 4 = 10$, as above.

(c) Subtract -8 from -3, and the answer is $-3 + 8 = +5 = 5$. Or, $-3 - (-8) = -3 + 8 = 5$, as above.

In multiplying like signs we get a positive product:

Multiply -6 by -8 and we have $6 \times 8 = +48 = 48$.

In multiplying unlike signs we get a negative product:

Multiply -6 by $+4$ and we have $6 \times 4 = -24$.

In dividing we have the same assumption:

Divide -2 by -8 and we have $+\cdot25 = \cdot25$.

Divide $+8$ by -2 and we have -4.

But the first few pages of any good elementary algebra should be a real joy to a genuine student of arithmetic.

Now to our table of logarithms to base 2 just completed and for the manner in which our various logarithmic values obey the laws enunciated. Let us consider this phase in a compulsory (more or less) theoretical sense, as under:

By the theory of logarithms multiply 4 by 8. This is

$\log 4 = 2$ added to $\log 8 = 3$ gives us $5 =$ the sum of both logs.

Look opposite under 5 in the table and we will find $32 = 4 \times 8$. Thus the performance of multiplication is reduced to one of addition of the logarithms of the factors.

By the theory of logarithms divide 8 by 2. This is
log 2 = 1 subtracted from log 8 = 3 gives us 2 = the difference in both logs.

Look opposite under 2 in the table and we will find $4 = \frac{8}{2}$. Thus the performance of division is reduced to one of subtraction of the logarithm of the divisor from the logarithm of the dividend.

By the theory of logarithms raise 4 to the 3rd power. This is
log 4 = 2 multiplied by 3 (the index) gives us 6 of the product.

Look opposite under 6 in the table and we will find $4^3 = 64$. This movement is called involution by logarithms. Thus the performance of raising any number to a definite power is reduced merely to one of multiplying the logarithm of the number by the exponent of the power to which the number is required to be raised.

Involving negative values we may have by the theory of logarithms as follows:

Multiply 32 by $\frac{1}{4}$. This is
log 32 = 5 added to log $\frac{1}{4} = -2$ gives us 3 = the sum of both logs.

In table under 3 we find the value $\frac{1}{4} \times 32 = 8$.

Divide $\frac{1}{32}$ by 2. This is
log 2 = 1 subtracted from log $\frac{1}{32} = -5$ gives us $-5 - 1 = -6 =$ the logarithm of the quotient by algebraical rule previously.

Look in table under -6 and we find the value $\frac{1}{32} \times \frac{1}{2} = \frac{1}{64}$.

Raise 4 to the $\frac{1}{2}$ power; or, find $\sqrt{4}$. This is
log 4 = 2 multiplied by $\frac{1}{2} = 1 =$ the product.

Look in table under 1 and we find the value (or the square root of 4) $4^{\frac{1}{2}} = 2$. This movement is called evolution by logarithms.

Very obviously we could go on and on in specific manner proving our argument relating to the logic of the theory with regard to the auxiliary number under the law of indices. But the three essentials under such law (set forth above) may be stated in general terms as hereunder:—

(1) $a^m \times a^n = a^{m+n}$.

(2) $\frac{a^m}{a^n} = a^{m-n}$.

(3) $(a^m)^n = a^{m \times n}$.

This combined law is efficient regardless of values indicated. That is to say, a, m, n may represent value of positive, negative, integral or fractional construction. However, the base (a) cannot be 0, or zero.

Now, further, without the nuisance of complicating our work for the student (we could, to be sure, frighten a West African nigger with a mass of p's and q's in the three laws above), we will observe that the foundation upon which the logarithmic function is built is the geometrical and the arithmetical progression. Let us then define both as under: The geometrical progression.

A geometrical progression is a series of terms each of which after the first is the equal of the product of the preceding term and a common ratio. Thus: 1, 2, 4, 8, 16, ..., conforms to the rule. In fact, any expression, say a^n, must be an embodiment of the geometrical movement. Take

$$20^4 = 20 \times 20 \times 20 \times 20 = 4 \text{ factors of } 20 = 16{,}000.$$

The G.P. movement to this end would progress by 1, 20, 400, 8000, 16000,

and that again would comply with definition. In the first, our common ratio was 2; in the last, this ratio was 20, as above.

The Arithmetical Progression: An arithmetical progression is a series of terms which is formed by adding a constant value negative or positive to the preceding term.

Take our own series (the logarithms) in A.P. as $\{ -6 + 1 = -5; -5 + 1 = -4; -4 + 1 = -3; \ldots\ldots\ldots; -1 + 1 = 0; 0 + 1 = 1; 1 + 1 = 2; \ldots\ldots; 5 + 1 = 6; \ldots\ldots \}$.

Or, we could have started at the other end for that matter, adding -1 to each term as $6 - 1 = 5$, etc., down to -6 through zero or 0. Notice that a G.P. may never reach 0, but the movement in A.P. proceeds to 0 and passes through to negative numbers.

Of course any student whose knowledge is that of Fourth Form will readily see that the underlying structure in our work performed in multiplying, subtracting, etc., was based upon the idea that if we keep to the geometrical in strictness, a rendezvous, so to speak, is kept with respect to a final reckoning along the highway or pathway, formed. That is to say, our various indices, or logarithms, which individually is the index of the power to which the base of the system must be raised, show to us the "signal light" where the travel ends. If this remark should not be clear, we would refer any reader, so affected, back to our small but efficient progressions (with worked examples) shown previously.

But the conflict in reasoning which harasses most boys and girls at school-leaving age is that they are at most only asked in lessons to utilise the auxiliary number. Few, probably not one in a hundred, have any idea as to the properties contained in such auxiliary number—how it has originated—how formed. And hardly any students are able to define a logarithm, let alone compute one. We are sure most "daddies" will recognise that smooging —furtive look, and at last: "Daddy, will you just show me how to do this one sum" from their little sons and daughters on the arithmetic evenings. Yes, we do agree with readers at this point and to the effect that the average man is not so hot at arithmetic. So much for that, and now we come to a very useful question in our discussion. It is:

Would the progressions involving base 2 be of any utility in actual practice? We answer this by saying "No." In amplification, just imagine the gaps left therein between 1, 2, 4, 8, 16, etc., with no corresponding logarithms tabulated to meet the values so apparently missing, and this is assuming larger and larger gaps to be satisfied as the progression proceeds to the end. What about our values with decimals as part thereof? What about the negative side with its myriads of numbers? No! As a matter of fact there are literally countless thousands of values to be constructed—and impossible of structure with any base except that of 10. However, our small table to base 2 is one which is worth following, because we are of the opinion that in dwelling upon such, no doubt at all will be left in the minds of readers as to why, when having to resort to a table of logarithms, multiplication, division, etc., problems—and bringing in any old value at random—may be accomplished in the time taken to say "Jack Robinson."

For this let us take between (1) and (2) in the geometrical progression and then compute some additional powers of 2 with corresponding logarithms. We have no great accuracy, but our figures will be authentic enough to allow the "rendezvous" referred to previously to be kept in specific circumstance. Then we would have

0, ·111, ·222, ·333, ·444, ·555, ·666, ... , 1. . . . . , 2, ...
. . . . 1, 1·080, 1·166, 1·260, 1·360, 1·469, 1·587, ... , 2, ... , 4, ...

Let us now say, to satisfy our reasoning, that we have set ourselves the task of computing the logarithm of "every number in the world" to base 2. But, what a miserable start! Actually we have only calculated about eight numbers in skeleton form, together with corresponding auxiliaries. Nevertheless, we have sufficient for illustrative purposes. Now here is the point.

$2^{\cdot 111} = 1{\cdot}080$; $2^{\cdot 222} = 1.166$; $2^{\cdot 333} = 1.260$; and so on to the end.

The structure in arithmetical and in geometrical progression is still intact as before, but let the table fall into the hands of the uninitiated while he watches the following problems being solved, and the result for him will be plain mental chaos.

(1) Multiply 1·080 by 1·360. The logs of both added (·111 + ·444) = ·555.

∴ 1·08 × 1·36 = 1·469, and the "rendezvous" along the path is kept.

(2) Divide 1·587 by 1·360. Take the log of 1·360 from the log of 1·587; this is (·666 − ·444) = ·222.

∴ 1·587 ÷ 1·360 = 1·166, and again the "rendezvous" along the path is kept.

(3) Raise 1·080 to the 3rd power. Multiply log of 1·08 by 3; this is ·111 × 3 = ·333.

∴ $(1{\cdot}08)^3 = 1{\cdot}260$, and the elephant never forgets. Neither did the geniuses who invented logarithms.

And, furthermore, any novice may discover that the movements in the foregoing were only made possible by the fact that instead of putting our numbers in their natural state as 1, 1·080, 1·166, etc., all were transformed and shown as the power of a base number (2). Thus:

1·08 × 1·36 can only be (stating as powers of 2) equal to

$2^{\cdot 111} \times 2^{\cdot 222} = 2^{\cdot 333} = 1{\cdot}469.$

And as we have taken the trouble (initially) to tabulate that truth, the reasoning is there for all time by mere inspection. The other two laws are just as easily interpreted if we care to take the trouble to make observations thereof.

Enough of this stuff, though, since the number (10) (or the radix of the scale of notation) is the only base possible for practical usage. Let us make some examination of the great advantages accruing under such a system. But do not become alarmed, interpretation of the algebraic movement is not called for—many readers no doubt will readily grasp the situation—neither is it necessary to worry in such regard.

In the following series we find the means whereby the computer could take any number whatsoever and state it to be the power of some other number called the base. There is also a modification of the series to meet certain requirements, but this does not interest us in what is to be demonstrated, and so readers' mental capacity will remain unchallenged also in this regard.

Nicholas Mercator was an illustrious algebraist who lived two hundred or so years ago. It was he that perfected (so it would seem) the original logarithmic series. It is when x represents a small proper fraction, we have

$$\log_e(1 + x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \ldots\ldots$$

That is the "Mercatorian" series and named after the brilliant mathematician that deduced its improvement.

Say our fraction $x = (\cdot 0325)$; then to calculate the logarithm of 1·0325 to the base e, or (2·7182818 . . .), we would show (just in brief):

$$\log_e(1{\cdot}0325) = \frac{325}{1 \times 10000} - \frac{(325)^2}{2 \times (10000)^2} + \frac{(325)^3}{3 \times (10000)^3} - \frac{(325)^4}{4 \times (10000)^4} + \ldots$$

$= {\cdot}031983045853 = {\cdot}0319830459$, to 10 places of decimals.

$\therefore$ ·0319830459 is the logarithm of 1·0325 to base e.

This is, in other words, if we took the base e to the 319830459th power, and in turn extracted the 10,000,000,000 root thereof, the result would be 1·0325. Then

$e^{(\cdot 0319\ldots)} = 1{\cdot}0325$, and simple enough, goodness knows.

But, generally, if we put

$$a^x = y$$

we get $\log_a(y) = x$.

Napier and Briggs, as well as their contemporaries, missed badly in that above; and, in consequence thereof, all logarithms had to be computed under the doctrine of stupendous power raising and root extractions, plus methods of approximations, the wonders of which may never cease to intrigue mathematicians while man continues to exist. It was later-day algebraists like Newton, Wallis, Mercator, Gregory, Halley, and others of little brilliancy who were able to demonstrate in adequate measure that algebraical method (but proceeding through the limiting value e or (2·71828 . . . .) in reaching the desired end) was the missing link in the process in equating $\log_a(y) = x$ in terms of arithmetic.

But any logarithm may be transformed so as to show it as one to a different base. Say we require the above logarithm to be shown as one to base 10. Yes, base 10. What a marvellous number! For the operation we would have

$$\cdot 0319830459 \times \cdot 43429448 = \cdot 0138900603.$$

This in turn indicates that

$$10^{(\cdot 0138\ldots)} = 1{\cdot}0325.$$

The transforming factor (usually notated μ) is called the modulus.

In a brief study of elementary algebra we seem to feel, after being sensible of the difficulties surrounding Napier and Briggs, was it any extraordinary thing that both should be utterly nonplussed—and which brought forth Briggs's ". . . . I cannot finish them to my mind."

Briggs took his table to 14 decimal places.

Now here is where the marvel of base 10 lies:

We have—

0, 1, 2, 3, 4, . . .
1, 10, 100, 1000, 10000, . . .

also—

0, −1, −2, −3, −4, ...
1, $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, $\frac{1}{10000}$, . . .

In this series we observe that the logarithms of 10 and multiples of 10 are ascertained by sight merely. Again, we may discern that the logarithm of 10 and of those resultant from the divisional process of dividing 10 by 10 successively are ascertained similarly. For example, in the first, if anyone asked us what the 4th power of 10 was, we answer by mental effort merely saying 10,000. This is from the fact that 4 zeros are visualised and so tacked on to the 1 (or unit). Then, conversely, what is the power of 10 where 10,000 may be manifest? Why, simply 4, since it has a complement of 4 zeros. But let us illustrate the facilities in both aspects, taking the value 1·0325 to bring out the supreme advantage of the theory. We have

log 1·0325 = ·0138900603
„ 10·325 = log 10 + log 1·0325 = 1·0138900603
„ 103·25 = „ 100 + „ „ = 2·0138900603

log 1032·5 = „ 1000 + log 1·0325 = 3·0138900603
„ 10325 = „ 10000 + „ „ = 4·0138900603
„ 103250 = „ 10^5 + „ „ = 5·0138900603
etc., etc.

Again—

log 1·0325 = ·0138900603
„ ·10325 = log $\frac{1}{10}$ + log 1·0325 = $\overline{1}$·0138900603
„ ·010325 = „ $\frac{1}{100}$ + „ „ = $\overline{2}$·0138900603
„ ·0010325 = „ 10^{-3} + „ „ = $\overline{3}$·0138900603
etc., etc.

From the above do we not see, when looking at the logarithm of 1·0325, or of ·010325, etc., in quite automatic fashion a huge mass of other logarithmic values is inherent therein and to be produced at will without any computation whatsoever so long as the significant digits in the natural numbers take the same order. Obviously in the movements shown above we have only resorted to the laws of indices already outlined in elementary style. And when the logarithm of one factor, say in our case 1000, is known by sight for 10^3, we only find it necessary to calculate the logarithm of the other factor 1·0325 to provide the logarithm of the product = $10^3 \times 10^{(\cdot 0138\ldots)}$ =1032·5. In the interpretation of such theory, if some person asked us to compute the logarithm of 1,085,298 we would take two factors as 1,000,000 and 1·085298 (but might not in practice). In view of the fact that the logarithm of 10^6 would be known by sight as simply 6, it is only requisite to produce the logarithm of the other factor and of course quite automatically (10 being the base) a huge array of logarithms of other numbers is produced. Just try this on with any other base than the radix scale? We notice from the small series of numbers put forward that the fractional portion of the logarithm (the mantissa) never changes and it always assumes positive quantities. But it is the integral portion (the characteristic) which always undergoes a change from positive to negative according as to whether the natural number is 10 +, or purely fractional. In a table of logarithms to base 10, the various characteristics are never tabulated for the reason (as suggested above) that we know each by sight. Hence, if we consult any standard work, the natural numbers therein will proceed from, say, 1, 2, 3, 4, 5, ... , 10325, ... , 100,000. The corresponding logarithms would be: (000 . . .), (·301 . . .), (·477 . . .), (·602 . . .), (·698 . . .), ... , (·013 . . .), ... , (000 . . .). This is so, as, under the theory, if we wish to ascertain the logarithm of 103·25 we know by sight that the characteristic to be written is 2, because $10^2 \times 1{\cdot}0325 = 103{\cdot}25$. Then by table, log 103·25 = (2·0138 . . . .). In finding the natural number corresponding with (2·0138 . . . .) we are guided by the characteristic in respect of the placing of our decimal point in such natural number. This is simple, and if 2 be the integral portion, as we observe it is, then the decimal point must be inserted to make for hundreds. That assumption is very obvious since $10^{(2\cdot0138\ldots)}$ could not = 1,000, but must = 100 multiplied by some value $10^{(\cdot0138\ldots)}$, both factors = 103·25, and no doubt about it at all. It is also very elementary where the negative side is to be considered. If someone asked us to discover the logarithm of ·00010325, we would again interpret the number in the light of ·0001 × 1·0325 = $10^{-4} \times 1{\cdot}0325$. However, the movement might be more clear to our readers if the following is noted carefully.

The logarithm of ·00010325 is obviously $\overline{4}$·0138900603 where we keep the mantissa positive. But as a negative quantity, in total, we have its

equivalent as $-3{\cdot}9861099397$. This should not be very difficult to decipher. Therefore, the 3 zeros shown in the natural number is in conformity with the -3 indicated by the characteristic of the logarithm. It must be so since 10^{-3}, or $\frac{1}{1000}$, $= {\cdot}001$, and 10^{-4}, or $\frac{1}{10000}$, $= {\cdot}0001$, making clear that the function cannot descend to 10^{-4} and therefore the logarithm must be $-3 +$ a negative decimal quantity. In actual fact, as stated before, the value is $(-3{\cdot}986\ldots)$, and of course $10^{(-3{\cdot}986\ldots)} = {\cdot}00010325$ accordingly. However, in tables our various mantissae are kept positive for convenience and so for our value above we do take $(\overline{4}{\cdot}01389\ldots)$, which means that a positive 1 has been added to the negative mantissa, and, to compensate therefor, negative 1 has been added to the negative characteristic. And so to ascertain the logarithm of ·00010325 from tables we put the negative characteristic 1 more than the zeros indicated (after the decimal point) in the natural number. For the converse operation we know by sight from the characteristic in the logarithm where the decimal point has to be inserted. Say in the case of $(\overline{2}{\cdot}01389\ldots)$ we would be aware that the decimal point must be followed by 1 zero, as ·010325, in producing the corresponding natural number, since there must be (from what has been demonstrated) 1 zero less than is indicated by $\overline{2}$ (say 2) in the characteristic.

And this is a very very short story surrounding the means by which man was able to calculate the logarithm of every number in the "world"; or, in other words, to show "every number in the world" as a power of 10 by simply taking the logarithms of 1, 2, 3, 4, ... , to say 100000, and then working by methods of factorisation and proportional parts easily interpreted from prepared tables.

Finally, where is the great mystery respecting the means of keeping a rendezvous in geometrical sense? The real truth is that no mystery exists in such connection, when once we become familiar with the ingredients of both movements. It is in fact just a matter of stating every number, which we involve, as a power of a definite base number and in order that the arithmetical values (or logarithms) can point out the "meeting" place. Under the post office clock "she'll be there alright."

To make a display of the many uses to which the logarithmic function may be put would cause the production of a huge volume. In respect of the presentation of graphic charts alone, the matter to be disclosed would be considerable. Very few accountants or secretaries understand the ratio graph, and we do say the profession suffers thereby. Later we shall endeavour to provide a concise article of salient points on the practice of the logarithm. But for one practical example before we close the following may be noted.

If it is required to know the amount of £1 in 98 years at 2½% p.a. compound interest, we have as follows. By the theory of logarithms, in working to this end, we commence to think of 1·025 as the equivalent of some power of 10 and in terms geometrical. Therefore, for the initial movement we have to state the logarithm of $1{\cdot}025 = ({\cdot}010723\ldots)$. Thus have we changed its mode, but not its value, to a function $10^{(\cdot 0107\ldots)}$. Now multiply this logarithm by 98 and we get $(1{\cdot}0509388\ldots)$ which is very clearly the logarithm of $(1{\cdot}025)^{98}$, or of $10^{(1{\cdot}0509\ldots)} = 11{\cdot}244465\ldots)$. Very difficult?

Thus $(1{\cdot}025)^{98}$, or £1 in 98 years at 2½% p.a. equals £11/4/11, near enough. If we required to ascertain the amount of, say, £85,752 as in the similar set of circumstances as above, then

log 1·025	=	·010723865392
98 times „ „	=	1·050938808416

also,

log 85752	= 4·933244257914
add	= 5·984183066330 to produce logs of product.

Then factorising for our antilogs, since tables are convenient for such procedure, we have:

log 964230	= 5·984180639522 = next lower log to that above.
Diff	·000002426808
log 1·0000055	·000002388613
Diff	·000000038195
log 1·00000009	= ·000000038195.

Multiplying such factors 964230, 1·0000055, 1·00000009, by short form of multiplication as

100000559
32469
900005031
60000335
4000022
200001
30000
964235·389

(Note: In multiplying these factors we do not worry about the decimal points since the characteristic in the logarithm safeguards the procedure, i.e., 5 in characteristic 6 integers then decimal point in number).

∴ The amount of £85,752 in 98 years at 2½% p.a. compound interest = £964,235/7/9, nearly exact. When dwelling upon this work from the angle of tables, it is far better to make one or two places of decimals more than may be required. Correctness is the main consideration at all costs. Personally, we have found that once a multiplication such as, say, 3·29 × 6 is mastered by the student, it is then only a matter of about 12 months' hard study when a multiplication such as 3·291 × 61 becomes comparatively easy. Thank you again, ladies and gentlemen. We are so glad that you comprehend the true meaning of this statement. Of course there are many logarithmic tables upon the market and a really excellent one for the student is Chambers's seven-figure work. In the matter of our problem above, this table would show:

log 1·025	=	·0107238654
98 times " "	=	1·0509388092
log 85752	=	4·9332443
Now add	=	5·9841831092
∴ log 964235·4	=	5·9841806
		25
		23
		20
		20

by proportional parts, very effective and taking only about 10 seconds for the whole function.

This result is only 3d. difference for that at first (8/- against 7/9) and quite insignificant as the problem stands.

Overhead Costing Problems in War Time

(A series of short addresses delivered by members of the Australasian Institute of Cost Accountants, Victorian Division Research Group)

Importance of Overhead Costing

By A. H. Blamey

Many factors are now operating to accentuate the importance of overhead in costing. Greater mechanisation of industry to conserve manpower and to lower the product cost is increasing the importance of overhead as a cost. A trend to greater efficiency in production means more planning and services for the operative and higher rates of overhead and a greater need for accuracy in its apportionment. Most Government departments, also, are "overhead conscious," paying particular attention to high overheads. The "squeeze" by the Price Commissioner and the Department of War Organisation of Industry on cost and prices is causing more executives to study the vagaries and incidence of overhead expenses, especially to ascertain the additional cost caused by defence jobs as distinct from civilian work.

Accountants, particularly in repetition engineering factories, have been discontented with the usual arbitrary methods of applying expenses to the cost centres and their application by one overall or operating time rate to the product cost.

One accountant found that after exercising every care his machine hour rate was composed of from 30% to 50% arbitrarily allocated charges, and similar machines in different departments had as a consequence widely different rates. Another accountant found that only 22% of the overhead expense could be said to have any direct relationship to the prices or operational time for the product.

Factories, both here and overseas, have altered their entire overhead costing procedure to allow the application of many expenses more directly to the product.

The use of time cards was extended to cover office and administrative employees so that they could record their costs to specific products or group of products. In one of the cases mentioned earlier where the departmental expenses were finally costed to the product on a machine hour overall rate, only 22% were now applied in this way and 55% of the expenses were charged direct from time cards kept by draughtsmen, supervisors, and other members of the factory management.

In addition to the wider use of time cards, more functional units than processing time were employed to apply some of the other expenses. Particular products or groups of products have certain characteristics such as bulk, weight, value, intricacies, each of which may have a definite bearing and influence on the volume of expense. There are also circumstances or factors relating to the method of manufacture, etc., which may mean greater handling, planning and supervision and other costs than attached to the general products. The actual processing is generally only a small proportion of the total production time or time in the factory during which expenses are being incurred, e.g., storage and insurance, etc.

In many factories it was found that these influence expense to such an extent that it was desirable to employ a charging unit that expressed the characteristic, for the purposes of allocating the cost to the product or class of production or, in the first instance, to the cost centre. Individual expenses

will be identified and grouped under their influencing factor, and this applies not only to factory costs but to distribution and administrative expenses as well, e.g., storage and cartage may be chargeable by a bulk unit such as a ton measurement, clerical expenses by the number of requisitions or number of product items on the invoices, cloakroom, timekeepers, pay-roll compilation may be applied to the cost centres by the employee hour.

By means then of charging more expenses directly to the product or cost centre, and by the use for certain expenses of a more functional unit than a processing hour, a better representation of the overhead expenses attributable to the production of a product is obtained and provides a more reliable basis for management decisions.

In addition to the desirability of greater accuracy in the apportionment of expense, it is necessary in war time, as in peace, to maintain the monthly cost checks. In spite of staff difficulties, the very uncertainty of the times makes it imperative that management should have a clear picture of the progress of a business and that overhead should be recovered at least monthly.

It has been found in many businesses, including those of a smaller type, that the monthly calculations of expense rates has the advantage of quicker adjustments with Government departments, the easing of the financial burden, the prevention of the piling up of office work, and the avoidance of losses due to war work reducing volume or incurring more expense than realised. Particularly, costs on work in progress must be watched as these are indicative of the profit result of the month to come and disclose adverse trends earlier. The comparison of the costs to date of each job by each department against the estimated cost should in these days be routine procedure.

What is the Best Method of Applying Expense?

By A. D. Richmond

Expense application is not merely a procedure to get rid of expense against products or jobs. That would be easy and dangerous. In war time, with ever-increasing restrictions in cost and price control, the question of correct application of expense is of vital importance to every business, no matter whether it be on cost plus, target price, cost check, or concerned with the Prices Commissioner.

To have the best method of applying expense to production, consideration must be given separately to:

(a) Manufacturing or factory expenses;
(b) Administrative and general overhead expenses.

Manufacturing or Factory Expenses

With manufacturing and factory expenses, it may be taken as a general rule that the "time element" is the basis for application. All expense is purchased on a time basis. This applies to rent, insurances, electricity, gas, repairs and maintenance, and each item of factory expense. All are being incurred hourly, daily, weekly or monthly.

The correct method of expense application, therefore, must observe the same principle. That is, as expense is purchased on a time basis, it should be sold on the same basis. Consideration must also be given to the rate at which it is incurred and charged. That is, if departments incur expense at varying rates per hour, separate departmental rates or percentages are needed.

If machines incur expense at varying rates, then separate machine rates should be used.

If this simple rule is followed, it will tend to supply the best method of manufacturing expense, which may be any one or a combination of any of the recognised methods.

However, although they may be "recognised" methods of expense application, it does not mean we have the correct method because we use one of them. There are pitfalls which can cause inaccurate results.

Percentage to Direct Wages

One method referred to in the Department of Munitions' Handbook is Percentage to Direct Wages. This is rather a common method, sometimes applied departmentally and sometimes to the factory as a whole. When the direct wages are the correct indication of time factor, this method is quite a suitable basis, but it should not be accepted without the fullest consideration.

For instance, I have seen some take the Profit and Loss Account and note the productive wages and the total expenses as shown in order to calculate the percentage to be applied to labour in costing products.

With wages, say, £1,000 and expenses £500, the calculation was 50%. This was definitely wrong. After analysing the Wages Account it was found to include sick and holiday pay, added value of overtime (not charged direct to jobs), supervision, etc. When these items were deleted from wages and added to expense, the figures were wages £900, expenses £600, which gave a more accurate figure of 66⅔% to apply.

Similarly, where highly-paid skilled labour is employed together with junior or female labour, it may be found that the product manufactured by skilled labour bears a larger proportion of the expense, although the junior or female employees may be incurring much more expense in the way of supervision, instruction, etc. This, of course, gives wrong costs, because the direct wages are not a true indication of the time factor nor the rate of incurring expense.

Care should also be taken when piece-work operates, as it tends to eliminate the time factor and overburden skill.

Anomalies arise with the percentage on direct wages when there are both machine and hand processes to be considered. It will be found that the production of a man operating a machine with a capital value of, say, £2,000 bears the same amount of expense as the production of a similarly paid man who is performing a hand operation. This, of course, is wrong.

Man-hour Rate

Another method suggested in the Department of Munitions' Handbook is the Man-hour Rate. This method is inaccurate if machines are concerned. Machines incur expense at a far greater rate than can be determined by a man-hour rate.

It must also be remembered that the man-hour rate is usually applied to the productive hour, therefore provision must be made for non-productive labour. Whether the actual or only a normal allowance be provided is a subject for special discussion, but here is the warning.

Machine-hour Rate

Where a variety of machines are concerned the Machine-hour Rate is probably the best basis.

The biggest problem with this method perhaps is the question of the cost of idleness. That is, having established that the expenses of a machine are, say, £30, and its normal productive time 30 hours per week, the machine-hour rate may be taken as 20/- per hour. However, if the machine worked only

15 hours per week, should 40/- per hour be charged to the work performed in the 15 hours? It may be argued that this additional cost is the cost of idleness, not to be charged to the work done, but treated rather as a cost of the work that was not done.

In the average business there are usually both machine and hand operations, in which case the best method of expense application is a combination of both man-hour and machine-hour rates.

Per Unit of Production

The fourth method suggested in the Department of Munitions' Handbook is one of charging so much per unit of production. This is only applicable where a single type of production is handled, such as pig iron, cement, etc., where a common unit of production passes through the whole of the operations in comparatively the same time.

Administrative and General Overhead Expenses

The Department's Handbook states that this expense may be expressed as a percentage of the total production cost or alternatively of the sales, and distributed pro rata over all departments.

A cost calculated on this method can be very misleading. For instance, if two articles went through similar operations in the factory and had the same labour and expense costs, but one was made of material with double the value of the other, it means the more expensive material must bear a larger proportion of the administrative charges, which is difficult to substantiate.

The handbook mentions that the allocation of administrative overhead pro rata to the direct wages paid can seldom be justified, but it seems that the statement is just as true if this expense is applied to production costs.

No matter what method be used to charge administrative expense against products, it must be an arbitrary one, and consequently is always open to anomalies.

The best method is probably to charge the administrative overhead according to factory volume, which is best indicated by the factory cost of that volume, that is, the labour and factory expense excluding material.

Conclusion

In conclusion I would say that in order to have the best method of applying expense to production,

(a) it must charge expense in the same manner and rate at which it was incurred;
(b) it must be carefully analysed and the basis of application correctly calculated;
(c) it must be proved continuously.

Should Costs of Government Contracts be Charged with Expenses of Unused Plant?

By N. J. Smith

This problem is one which has received greater attention since 1939 than previously, but it is not new. It has been discussed in textbooks and by lecturers any number of times.

To examine this widely discussed question we shall illustrate the costing principle involved by supposing we are operating two factories, one producing furniture and the other producing cheese. The furniture trade slackens, and we are compelled to close our furniture factory. We do not think of charging our cheese costs with the expenses of the idle furniture factory.

Similarly, if certain equipment within a factory is not required for production, costs of production should not be charged with the expenses of the idle plant.

It might be argued that in war time Government control has precluded the use of certain equipment and therefore Government costs should bear the expenses of that equipment. If that argument is sound, then Government costs should also bear the expenses relative to all factories and shops which have had to close down.

Such a proposal is impracticable. If a manufacturer is compelled to reduce production, the Prices Commissioner would probably not approve price increases on the remaining products in order to return to the manufacturer the expenses of his idle plant or unused capacity.

So far as civil requirements are concerned, exactly the same principles apply as to Government contracts. We cannot have one principle for Governments and another for other customers. And that cuts both ways.

The Government should not be at any disadvantage or at any advantage relative to other customers. Lower prices should not apply to Government departments for identical products. Under our present methods of profit control such discrimination amounts to a hidden tax on certain sections of the community, as lower prices to the Government mean higher prices to other customers.

To return to the main point. Accepting the principle outlined, there still remains the practical treatment of borderline cases.

Perhaps a certain machine was installed pre-war and operated part time only as its capacity was greater than actually required. It would have been correct to charge all expenses of that machine to costs of production.

If that same machine is necessary, essential, even for a fraction of its time, on war-time production, whether for the Government or not, then it would be reasonable to charge all its costs against production. The words "necessary for production" should be stressed. If there is an alternative cheaper way of producing, then costs by that cheaper way would be the maximum which should be charged.

In some industries large numbers of moulds and dies are included as plant, and it has been customary to charge the expenses of all of these to production costs, even though many would not be used during a particular period.

If under war conditions the plant generally is working to capacity, it would be reasonable to continue charging these expenses to production, even though relatively few moulds are used on war production. An alternative would be to charge the costs of the particular moulds used at an accelerated rate, which would probably give a similar result so far as total cost is concerned.

If a new set of moulds had been paid for directly by the customer, then no charges in respect of the manufacturer's own moulds should be included in costs.

There may be some factories in which a bank of similar machines is installed and only half are required for war production. The costs of half could be charged against production. If only one machine of the bank was idle, it may be reasonable under some circumstances to charge all costs of all machines to production. For instance, that idle machine may be a necessary standby to ensure continuous production.

Most problems in connection with expenses of idle machines or unused capacity depend upon the circumstances of the particular case. It is impossible to give a clear-cut rule for general application. The important point is to determine the principle and make a practical application of that principle.

How Should Expense be Apportioned Between Civil and War Production?

By W. J. Laing

In deciding the principles of apportionment we must consider the method of costing in use in any given business. For instance, are costs accumulated as:

1. Job costs;
2. Process costs;
3. Ideal or current standard costs;
4. Basic standard costs; or
5. A combination of two or more of these methods?

We must also compare the incidence of operations, pre-war and during the war. Is the business producing essentially the same products as during peace time, or different products from peace time, or a combination of both? Is the equipment utilised the same as during peace time, different from peace time, or is there a combination of both?

In general it will probably be found that most businesses operate under a combination of both types of production and equipment.

The general principle of expense application applies in war time, but the necessity of special treatment in apportioning some items of expense between civil and war production is largely governed by the above factors.

By way of example, let us examine the incidence of expense apportionment of one item of cost as related to the method of costing.

The item is overtime premium.

Direct Labour Overtime Premium: Under job costs it should, in general, be possible to treat this as a direct charge to the job concerned, although in some cases it may be treated as part of the burden rate. Under the process method of costing the distinction between direct and indirect costs is not as important as under job costs, as the tendency is to spread this item over the production of the period or run used in obtaining the average cost. Under standard costs, whether ideal, current, or basic, we must presuppose that some allowance has been made for overtime premiums as a direct or indirect charge to costing, and under these conditions the tendency will be to spread such premiums over jobs and contracts with any difference taken up in variance accounts.

Overtime Premiums Paid Indirect Labour should probably, in the main, be treated as an indirect charge, although in certain circumstances they may be accumulated in a special account and treated as apportioned direct charges.

Multiple Shift Premiums: This class of expenditure is particularly prevalent in war time as most plant is going flat out, and wherever possible it should be treated as a direct charge so that war production will bear its full quota of cost.

The costing problems confronting a prime contractor engaged solely in production of war work are entirely different from those of a sub-contractor who is manufacturing substantially the same product as during peace time and is supplying to both the prime contractor and the commercial consumer.

Some General Comments

By W. J. Laing

Generally speaking, the method of apportionment of expense to specific items or types of production is logically the result of different basic conditions, e.g.:

Direct Labour Overtime Premiums:

(a) A contractor constructing ships under single contract may logically combine overtime premiums with the ordinary labour charge.

(b) A company operating standard costs on a fixed basis of 88 hours per week may logically include overtime premiums and labour in the standard allowance, thus giving greater accuracy than treating such premiums as overhead.

The formulation of uniform accounting methods for a single industry would greatly decrease the problems and work of the cost accountant. The difficulty is, however, that unless such uniform methods reflect the particular conditions and situations surrounding each individual concern it will produce unfavourable reaction from the executives involved. Consequently, it is difficult to issue definite uniform rules covering the application of costs to Government contracts, and it is better to have general and elastic rules which follow good accounting practice.

Analysis of Indirect Cost: If various types of indirect cost are segregated and applied to jobs, contracts and products on a basis different from general departmental overhead, the result may be more accurate cost accounting, e.g., some costs do not vary in relation to time, either direct labour hours or machine hours, nor do they all vary with direct labour cost. Certain overhead groups are better applied on a machine hour basis, others on a direct labour hour basis; and in the case of our example of overtime premiums they are better applied in relation to the direct labour £, as would also such an item as pay-roll tax.

In summarising methods of spreading costs over time and production we have seen that the benefits are difficult to measure and the relationships often obscure. The goal is to spread indirect costs in proportion to benefit received by each period or product.

Here we have two conflicting elements. Costs are needed currently and benefits extend into future periods. The industrial accountant is thus forced more and more to depend on conservatism between current and future periods. In so doing, he encounters the other side of the problem in the shape of tax regulations, provisions governing pricing, provisions for future contingencies, and allowable and non-allowable items of cost.

In conclusion, we find that there is little possibility of making exact measurements and laying down fixed rules, but the application of joint costs to products and periods of time is the result of knowing all the available factors and the application of sound judgment in each individual concern.

Has Departmental Procedure Made For Efficiency?

By A. J. Gairns

The period of trial and error brought about by Australia's sudden plunge into total war has ended and the time has come to adopt procedures which will provide incentives for efficiency and lowering of costs.

We have been compelled to recognise the fact that the cost plus method and, to a smaller extent, the cost check method, of Government costing has not been conducive to efficiency in manufacture. Any manufacturer who is allowed to recover *all* the costs of production except specific disallowed items can be expected to assume that efficient operation of his plant is secondary to the production of the particular article required. He is not subject to the intense competition of peace time which enforces efficiency.

From the Government's viewpoint, there is little opportunity directly to control inefficiencies such as may be represented by excessive overtime loading, inexcusable scrap, and abnormal repair and maintenance expenditure.

In many cases the Government has simply paid the contractor what it considers a fair price after the contract is completed. This has happened in the textile industry and in the cleaning of army equipment. It puts too much emphasis on profits and pricing control, rather than on efficiency and lower costs.

The better procedure is to arrange a competitive price before the start of the contract, giving regard to those factors which can be classed as loading cost by rush snap buying, waste, etc. This is preferable even if it leads to some excess profits, as it allows the firm some incentive to reduce the cost, which benefits the war effort.

The profit incentive cannot be divorced from the question of cost and efficiency, and proper administration by the Government departments calls for the establishment of a clear policy that good producers will be rewarded with substantially greater profits than poor producers. Where performance is equal, the efficient low cost operator should be allowed not only as much money profit as his higher cost competitor (and this is not the case under cost plus) but also a further sum in addition so that the manufacturer as well as the Government will benefit directly from the savings achieved.

Contracts known as the "target method" are being issued but need to be popularised more. Under this system a price is fixed beforehand, subject to the usual rate of profit, and if savings are effected by increased efficiency they are divided by the contractor and the Government by increasing the profit margin by a predetermined portion of the saving effected.

This type of contract may provide the answer to those not satisfied with the present conditions and who wish to maintain their efficient set-up.

The Minister of Munitions has lately formed a directorate of technical practices with the aim of discovering by tests carried out by their technical officers the reason why methods of manufacture of so many factories differed. The methods which they consider to be the most efficient will be applied to all factories. The measure of factory efficiency selected would be the present actual cost of operations, and cost would be obtained from five or six factories making the same type of goods and would cover a similar period of time and conditions. Where possible, the investigators would seek to cost up overhead in conjunction with the prime cost to discover whether there is a greater or more efficient use of machinery. This is a move in the right direction and augurs better things for the future.

Correspondence

The Editor,
The Australian Accountant.

Sir,

A copy of the May issue of our journal containing my article on Canadian Income Tax was forwarded to Mr. C. F. Elliott, the Dominion Commissioner of Income Tax. As I had been unable to obtain a complete copy of the Act, it is satisfactory to learn that "except for a few minor errors, this article is a very good summary."

The "minor errors" should, of course, not have occurred; I am accordingly passing on those to which Mr. Elliott refers.

(i) My suggestion (*A.A.*, page 186) that there could be difficulty in interpreting "self-contained domestic establishment" is to some extent ill-founded as the Act contains a definition of the term. It is "a dwelling house, apartment or other similar place of residence containing at least two bedrooms, in which among other things the taxpayer as a general rule sleeps and has his meals prepared and served." I should, however, still anticipate that there have been disputes about borderline cases.

(ii) Claims by individuals for deduction of charitable donations (page 187) is limited to 10%, not 15%, of net taxable income. A misprint has crept in somewhere.

(iii) The duties of the Board of Referees (page 190) are "confined to setting 'standard profits' for the purposes of the Act, in such cases as new businesses and old businesses which were depressed in the standard period or had profits so small during the period as to make it unfair to determine standard profits on the basis of profits in the standard period. The Board is fully occupied in dealing with these problems and does not deal with any other questions arising out of the Act."

A. CLUNIES ROSS.

Sydney,
October 19, 1943.

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